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Bald Eagle Winter Habitat on Southwestern National Forests

Teryl G. Grubb and Charles E. Kennedy

Abstract

An extensive, winter survey and habitat study in 1978 located about 100 bald eagles in Arizona and 350 in New Mexico. Perching habits varied greatly but predictably. Limited in number and consistently used, roosts appear to be the most critical for management. Fluctuations in prey populations provided the opportunistic eagle with a food base changing in composition but consistent in overall availability. Study results offer some qualitative insights for habitat managers.

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Teryl G. Grubb, Research Wildlife Biologist
Rocky Mountain Forest and Range Experiment Station[1]
and
Charles E. Kennedy, Forest Biologist
Coronado National Forest[2]

[1]*Headquarters is in Fort Collins, in cooperation with Colorado State University. Research reported here was conducted at the Station's Research Work Unit at Tempe, in cooperation with Arizona State University.*
[2]*Tucson, Ariz.*

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Management Implications

The winter bald eagle[3] population in Arizona and New Mexico is widely scattered with few concentration areas. This population varies over time and area in response to changes in weather and prey base. Most eagles winter on northern or higher elevation Forests, where water is abundant and prey species concentrate; the Gila National Forest and the Coconino National Forest have higher wintering eagle populations than any other National Forests in the region. Identified patterns of daily and seasonal behavior will be useful for monitoring wintering eagles in the future and in assessing the value of specific use areas.

Perching is opportunistic, yet the eagles' preference for sites from which there is high visibility would allow managers to improve the characteristics of perches in areas which are marginally suitable habitat for eagles, or to shift use by providing better perches. Foraging varies less and is more appropriate for management. Wintering eagles will not remain in an area that lacks a suitable prey base. American coots and other waterfowl were the major prey used in 1978, followed by large ungulate carrion and small mammalian prey, which were more evident in the diet than were fish. Management practices beneficial to waterfowl should benefit wintering eagles in the vicinity. It may also be possible to supplement or modify the foraging activity of eagles by placing carcasses at selected locations. Research is needed on the extent of utilization of mammalian prey and on the upland wintering habits associated with this utilization.

Because of their limited number and consistent use, roosts are the most critical winter habitat component needing management protection to favor eagles. Roosts may nocturnally concentrate eagles that range over a wide area; they also provide physical protection and an opportunity for social interaction (Hansen et al. 1981). Although easily stereotyped as stands of large living trees protected from severe weather, roosts are not easy to find, because they are normally up to several miles from the area of daytime activity (Grubb (in preparation),[4] Swisher 1964). Continued monitoring of winter eagle populations on the Forests is necessary in order to locate additional roost sites.

Because of the very mobile nature of wintering bald eagles in the Southwest, their winter habitats can be affected by many management practices. Although human use of forests is generally reduced in the winter, hunting, fishing, snowmobiling, and other winter recreational activities can have negative impacts (Skagin 1981, Stalmaster and Newman 1978). Management guidelines should be based on an evaluation of the type and extent of eagle activity affected, recreational pressure, and the available alternatives.

[3] *Scientific names of plants and animals are listed in appendix.*

[4] *Grubb, T. G. Bald eagle winter activity at Navajo Lake, New Mexico. Manuscript in preparation, Rocky Mountain Forest and Range Experiment Station, Research Work Unit, Tempe, Ariz.*

Introduction

This study was undertaken to identify areas of critical habitat for bald eagles wintering on National Forest lands in the Southwest. Priority was given the wintering migrants because, in 1977, they represented a portion of the North American eagle population proposed as endangered but not addressed by a recovery team or a recovery plan. Subsequently, all bald eagles in the lower 48 conterminous states have been classified under the Endangered Species Act as threatened or endangered. Aerial surveys during the winter of 1978 resulted in population estimates of 350 wintering bald eagles in New Mexico and about 100 in Arizona, but little was known about the distribution of this population of eagles and the kinds of habitat necessary for its continued support. This study was designed to provide that information.

Grubb and Kennedy (1982) compiled the data collected by National Forest under the following headings: numbers and distribution, historical records, perching, foraging, roosting, and disturbance. That paper documents winter use areas on southwestern National Forests and gives detailed descriptions of the specific perching, foraging, and roosting sites identified. Although this paper summarizes those results, it is intended primarily to provide a qualitative discussion and interpretation with implications for management and further research.

Study Area

The 11 National Forests of the Southwestern Region of the Forest Service covered during this study are illustrated in figure 1. The ground survey effort was concentrated almost exclusively on these Forest lands; however, aerial coverage was extended to all major drainages and any reported or suspected wintering areas in both states. Vegetation of areas used by eagles typically ranges through the pinyon-juniper and ponderosa pine types, occasionally extending into Douglas-fir or sagebrush grassland types. Along major drainages, riparian areas characterized by cottonwood, willow, and sycamore associations cut through these elevational types and are frequently important to

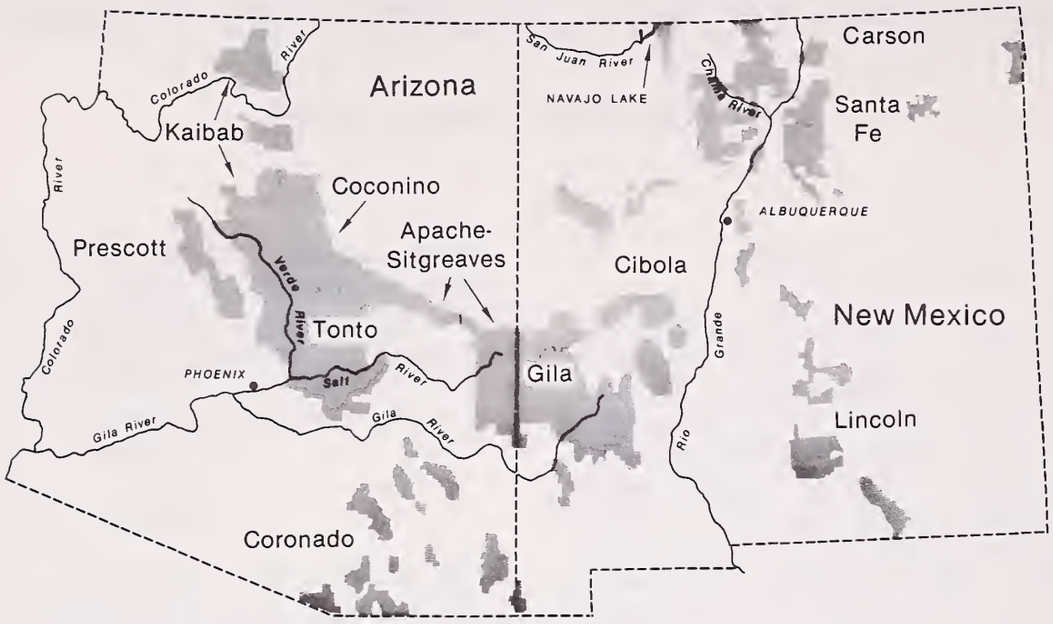

Figure 1.—Map showing location of Arizona and New Mexico National Forests.

wintering bald eagles. All but the drier Coronado and Lincoln National Forests have such drainages. Major reservoirs are common on or near the Tonto, Carson, and Santa Fe National Forests, while numerous small lakes and stock ponds are found on the Apache-Sitgreaves, Coconino, Kaibab, and Gila National Forests. Winter weather conditions vary locally with elevation and regionally with latitude, but snow and cold weather are rare on the Coronado and much of the Tonto National Forest.

Methods

This study was conducted from January 15 through April 7, 1978. The 11 field technicians working on the project were usually deployed in pairs to provide more complete coverage and because of the hazard of back country winter travel. Occasionally, personnel shifted from Forest to Forest to provide additional coverage on those Forests with large numbers of eagles. On each National Forest, the Forest biologist prioritized the known and suspected wintering areas to be checked and also suggested which Forest personnel, local residents, etc., to contact for historical information. Crews observed concentrations of bald eagles at length to determine perching, foraging, and roosting sites. They systematically surveyed areas with few or scattered wintering eagles, usually on foot or by vehicle. Some inaccessible areas suspected to have winter eagle populations were observed from the air first to determine the extent of use prior to ground checking.

Using binoculars and spotting scopes in the field, each team kept a daily log of their activities and of any observations made on eagles or their habitat. Observers summarized daily eagle sightings and recorded habitat characteristics of identified use areas on field forms. (Grubb and Kennedy 1982) Small fixed-wing aircraft (Cessna 206, 210, Skymaster)[5] and a helicopter (Hiller SL-4)[5] were used on the aerial survey flights conducted in February, March, and April for both wintering and nesting bald eagles in Arizona and New Mexico. Information gained from this aerial work helped to assign ground teams effectively as well as to assess overall population numbers and distribution. Population estimates were derived primarily from the field technicians, who used a combination of field observations, reported information, and deductive reasoning to arrive at eagle numbers in their respective areas.

Results

Areas Surveyed

Nearly 3.5 million acres were surveyed in Arizona and New Mexico through the ground study and aerial surveys (table 1). The acreage covered by aerial surveys was figured using the flight path and/or the hours flown times the average speed, with an estimated average swath of coverage of 0.5 miles (i.e., 0.25 miles on either side of aircraft). This width was based on personal experience (Grubb 1978, Grubb et al. 1975) and modified from Grier et al. (1981) to accommodate the open terrain surveyed in the Southwest. To document total effort, both the winter and spring flights are included in the aerial survey figures of table 1; thus the total figure includes some acreage observed twice. Revisits are not included in the ground acreage figures in table 1 because areas of high concentration were rechecked frequently. The 263,080 total acres from the

[5]*The use of trade and company names is for the benefit of the reader; such use does not constitute an official endorsement or approval of any service or product by the U.S. Department of Agriculture to the exclusion of others that may be suitable.*

ground surveys represent the actual area surveyed on the ground. This figure was derived from the acreages of lakes, reservoirs, and other water bodies and an estimated 0.25-mile swath of coverage along the observer's route of travel.

Numbers and Distribution

Wintering bald eagles usually begin arriving in Arizona and New Mexico by November. The population seems to peak in January or February, and nearly all wintering migrants are gone by the first of April (Todd 1978). The combined aerial and ground surveys of 1978 indicated a similar pattern, with a wintering population of approximately 100 bald eagles in Arizona and 350 in New Mexico. These approximations were made from actual counts of 185 adult and 167 immature eagles for the entire season in the New Mexico aerial surveys (Schmitt 1978) and from midwinter flights in Arizona showing 42 adult and 38 immature eagles.[6] The lake area near Flagstaff on the Coconino National Forest was the only area of significant winter eagle concentration in Arizona; and, even there, the birds were in small groups (5-15) scattered among different lakes. A similar concentration of scattered, small groups was evident on the Gila National Forest in southwestern New Mexico. Navajo Lake, just west of the Carson National Forest, was the only location on or near National Forest land in either state that consistently had a relatively large number of eagles (30-40 estimated) in one specific area. It appears that the most typical wintering situation in the Southwest is a large area, such as a major river course or collection of lakes, within which bald eagles are widely scattered, often perching, roosting, and feeding alone or in small groups.

An estimated distribution of the bald eagle winter population across the National Forests in Arizona and New Mexico is given in table 2. Although approximations, these figures show the relative density of wintering bald eagles on the various National Forests. Similarly, the numbers of person hours and of actual sightings indicate where eagles were expected and where they were located, respectively. In most cases, field person hour per sighting figures (FPH) also reflect the relative concentration of eagles and their accessibility for observation. In 1978 the Gila and Coconino National Forests had the largest numbers of wintering bald eagles in the Southwest. However, there were at least some wintering eagles on all the National Forests, making it difficult to rank the Forests where smaller numbers of eagles were more widely scattered and where concentrations were more variable in response to changes of weather and prey. In Arizona, the Apache-Sitgreaves National Forest also had an appreciable number of wintering eagles, followed by the Kaibab National Forest. In 1978, the Coronado, Prescott, and Tonto National Forests showed little eagle use. Similarly, in New Mexico, the Cibola, Lincoln, and the Carson National Forests (if Navajo Lake, which lies off the Carson National Forest, is not included) had few eagles in the winter of 1978; while the Santa Fe National Forest was intermediate between these Forests and the Gila National Forest.

[6] *Grubb T. G., and D. M. Rubink, unpublished data, on file at Rocky Mountain Forest and Range Experiment Station, Tempe, Ariz.*

General Habitat

As is typical throughout most of their range, bald eagles wintering on southwestern National Forests in 1978 tended to congregate around bodies of water. Although there was some variation, small- to medium-sized lakes and major river drainages were the most common hydrological situations (table 3). Elevation, latitude, and severity of the winter greatly influenced eagle distribution because smaller, nonflowing systems tended to freeze over as the winter progressed forcing the eagles to move to other areas. Unfortunately, a drought during the summer of 1977 left dry many of the lakes and stock tanks normally used on the Kaibab during the winter months. With only two notable exceptions (on the Apache-Sitgreaves and the Gila National Forests) few eagles were found on smaller drainages such as creeks, streams, side canyons, etc.; however, it was not uncommon to document several eagles frequenting an area containing several scattered ponds or tanks. In river situations, steep, narrow canyons with vertical walls separated by less than 300 feet supported few, if any, wintering bald eagles. Canyons on the Salt and Gila rivers in Arizona and New Mexico, respectively, are good examples. Qualitative analysis of notes taken in the field indicate that the number of eagles observed wintering along rivers or other bodies of water is inversely proportional to the degree of turbidity. Although this phenomenon is probably a function of prey availability, it has not been determined

Table 1.—National Forest acreage surveyed in the 1978 bald eagle winter habitat study and concurrent aerial surveys in Arizona and New Mexico

Location	Area surveyed		
	Air	Ground	Total
National Forests			
Apache-Sitgreaves	224,000	24,960	248,960
Coconino	89,600	45,440	135,040
Coronado	64,000	5,120	69,120
Kaibab	76,800	12,800	89,600
Prescott	57,600	5,120	62,720
Tonto	275,200	0	275,200
Carson	154,400	9,000	163,400
Cibola	51,200	3,200	54,400
Gila	96,000	32,000	128,000
Lincoln	0	22,400	22,400
Santa Fe	122,400	16,640	139,040
Total National Forest	1,211,200	176,680	1,387,880
Acreage surveyed off National Forests	1,987,195	86,400	2,073,595
Grand Totals	3,198,395	263,080	3,461,475

Table 2.—Estimated winter bald eagle populations, actual sightings, and field person hours (FPH) spent on National Forests in Arizona and New Mexico in 1978

Location	1978 Population estimates	Eagle sightings	FPH	FPH per sighting (Sighting per FPH)	
National Forests					
Coconino	75-125	327	540	1.65	(0.61)
Apache-Sitgreaves	25- 50	66	505	7.65	(.13)
Kaibab	10- 20	18	78	4.33	(.23)
Prescott	5- 15	8	16	2.00	(.50)
Coronado	5- 15	5	153	33.33	(.03)
Tonto	5- 15	7	0	-	-
Arizona subtotals	125-240	430	1292	3.00	(.33)
Gila	100-150	92	751	8.16	(.12)
Santa Fe	15- 25	55	393	7.15	(.14)
Carson (including Navajo Lake)	30- 50	146	444	3.04	(.33)
Cibola	5- 15	2	22	11.00	(.09)
Lincoln	5- 15	3	136	45.33	(.02)
New Mexico subtotals	155-255	298	1746	5.86	(.17)
Totals	280-495	706	3038	4.30	(.23)

Table 3.—Bald eagle winter use areas identified on southwestern National Forests in 1978[a]

Location	High use areas			Low use areas			Historical use areas		
	Lakes	Rivers	Misc.	Lakes	Rivers	Misc.	Lakes	Rivers	Misc.
National Forests									
Apache-Sitgreaves	3	1	1	1	2	3	16	1	2
Coconino	10						1		4
Coronado	1						1		1
Kaibab	1						10		4
Prescott					1			1	
Tonto				1	1		1	1	6
Carson	1	3		1				1	
Cibola									1
Gila	1	3	1	4	7	2	2	3	2
Lincoln							2	1	14
Santa Fe		1	1						2
Totals	17	8	3	7	11	5	33	8	36

Totals by use category	High: 28	Low: 23	Historical: 77
Totals by habitat	Lakes: 24	Rivers: 19	Misc.: 8

[a]*High use: consistent use by 1-2 eagles or where concentrations greater than 2 eagles occurred. Low use: occasional use, consistent but scattered use in large area, or no concentrations greater than 2 eagles. Historical (or reported use): reported areas of past use which were not checked, or if checked had no eagles. The miscellaneous category includes stock tanks, creeks, small canyons, etc.*

whether the effect is direct (e.g., resulting from fish being hidden from view) or indirect (e.g., resulting from high water driving prey from area). In Florida, Grubb (1977) found osprey hunting activity decreased when wind or clouds reduced visibility at the water surface.

Throughout the region, few bald eagles wintered along the lower river basins which run through drier, more open habitat; rather, most wintering eagles in both Arizona and New Mexico were documented at higher elevations, where the winter climate is more severe. At those higher elevations typical of the southwestern wintering situation, an appreciable number of bald eagles were observed over upland habitat well away from any significant bodies of water. Sightings of eagles perched, flying, or more typically, feeding on carrion in open rangeland were common and in some areas relatively consistent. Upland use was also noted peripheral to several rivers or reservoirs which had concentration areas, but the existence and extent of interchange could not be determined. Terrestrial wandering eagles (i.e., those not associated with any significant bodies of water) were usually seen in open habitat, including agricultural, rangeland, and pinyon-juniper areas. Many of the water-associated wintering areas were also within the pinyon-juniper type, but the ponderosa pine type was more typical. Eagles were also observed in the spruce-fir zone in higher elevations and in riparian stands, characterized primarily by cottonwood in river bottoms and along lake shores.

Perches

Nearly all the perches identified during the course of this study were in water-associated wintering areas. Daytime perch trees were usually along the shoreline, but were as far as several hundred yards from water, depending on variations in topography. Occasionally, eagles used snags in the water of artificial lakes (fig. 2). Ponderosa pine was the most typical perch tree species; it was also the most abundant and available species through most of the survey area. As shown in table 4, eagles preferred snags over living trees. In fact, if the dead-topped trees and leafless, dormant cottonwoods are included in the dead category in table 4, the percentage of perch trees which were dead increases to 77%. Depending on the activity (loafing, sunning, hunting, etc.) perches were oriented to provide all of the following, although not necessarily all at the same time: (1) a good view of the adjacent water and the surrounding area; (2) maximum exposure to the sun, especially during morning hours on cold days; (3) maximum benefit of topography and diurnal wind currents for flight. Usually eagles chose the largest trees with suitable branches. For example, on a Coconino National Forest lake with 15 dead juniper perch trees and 1 large ponderosa snag, the latter was used more frequently by more eagles (up to 6 at one time) than any of the other smaller trees. Perching eagles in the Southwest tended to be in the upper third of the perch trees and often used the highest branches. However, not all perches were in trees, i.e., it was not uncommon to see eagles on rocks along a ridge or on the ice of a frozen lake. Thus relative height of perches varied with the type of perch or its substrate, surrounding vegetation, and topography.

Roosts

Roosts were not as easily identified or located as perch sites. Only three to five specific roosts were found, but a variety of related observations provide additional insight. All the identified roosts were in ponderosa pine stands (continuous stands or isolated stringers) several hundred yards to several miles from the water resource associated with daytime activities. Occasionally, bald eagles were observed remaining in diurnal perches overnight. This happened where the

Table 4.—Species and condition of 153 bald eagle perch trees recorded on southwestern National Forests in the winter of 1978

Species	Living	Dead	Live, dead top	Species total
Ponderosa pine	27	83	8	118 (77%)
Juniper	5	17		22 (15%)
Cottonwood	6[a]	2		8 (5%)
Douglas-fir	1	1		2 (1%)
Scrub oak	1	1		2 (1%)
Pinyon pine	1			1 (1%)
Class totals	41 (27%)	104 (68%)	8 (5%)	153 (100%)

[a]*Winter cottonwoods were leafless and thus assumed the character of dead trees.*

Figure 2.—Bald eagle snag perches on an artificial lake in northern Arizona.

perch trees near small lakes were the only large or protected trees for some distance, and it also occurred at least once in apparent response to an unusually cold, calm night. More typically, eagles were observed in late afternoon flying identifiable routes up side canyons or toward forested hills, sometimes traveling 4-5 miles before being lost from view. On several occasions, birds from widely separated daytime locations flew in directions at sunset that would indicate a common roost. The widely dispersed, mobile populations of some river and upland situations suggested night roosting as individuals or in small groups as Southern (1964) has described along the Mississippi River; rather than in more typical, large, communal roost concentrations (McClelland 1973, Steenhof 1976). Those roosts identified were in protected sites, such as small canyons or draws. Usually several trees within 100 to 200 yards of each other showed evidence of use. Most roost trees were living and well foliated but with large "windows" in the canopy (figs. 3A-C).

Food Habits

During the winter of 1978, American coots were the food resource most frequently utilized by bald eagles on southwestern National Forests (table 5). A variety of other waterfowl, fish, and mammals were also taken, emphasizing the opportunistic nature of the bald eagle. On several occasions, wintering eagles adapted to a new source of prey, such as a deer carcass along the shore of a waterfowl lake; they reacted to a reduction in waterfowl by supplementing the diet with lagamorphs. Some lakes traditionally used by both waterfowl and eagles were dry much of the winter; yet when those lakes filled rather quickly from heavy rains and the waterfowl returned, bald eagles soon appeared. A more typical situation of which the eagles took full advantage was the concentration of waterfowl in small areas of open water as lakes and stock tanks froze over (fig. 4).

Figure 3A.—Ponderosa pine roost trees in a typical bald eagle roost in northern New Mexico.

Figure 3B.—High altitude aerial view of the same roost showing its proximity to a nearby lake and foraging area.

Figure 3C.—Low altitude aerial view [of the same roost] showing the roost location in a protected draw. The snag in the foreground was one of four high use roost trees within the stand.

Table 5.—Prey species identified in castings or remains at bald eagle wintering areas and predation attempts observed on southwestern National Forests in 1978[a]

Group Species	Observed attempts		Castings		Remains		Total	
Birds	22	(58%)	247	(89%)	71	(76%)	340	(83%)
American coot	19		203		66			
Mallard					2			
Pintail			(c)					
Unidentified waterfowl	3[b]		44		3			
Fish	12[b]	(32%)			5[b]	(5%)	17	(4%)
Carp					(c)			
Bluegill					(c)			
Pumpkin seed					(c)			
Brown bullhead					1[b]			
Northern pike					3			
Rainbow trout					1			
Golden shiner	6							
Mammals	4[b]	(10%)	25	(9%)	10	(11%)	39	(9%)
Cottontail/jackrabbit			18		5			
Elk deer[d]			5		1			
Antelope[d]			1					
Wood rat					1			
Coyote[d]					1			
Cow[d]			1		1			
Horse[d]					1			
Invertebrates			7	(2%)	8	(8%)	16	(4%)
Freshwater mussel[e]			5		7			
Scarab bettle			1					
Jerusalem cricket			1					
Totals[f]	38		279		94		411	

[a]*It was rarely possible to determine the number of individual animals represented, so totals and percentages based on castings and remains must be considered approximate.*
[b]*Additional observations not recorded in field notes.*
[c]*Number of observations not recorded.*
[d]*Known only as carrion from road or winter kill.*
[e]*Grubb and Coffey 1982.*
[f]*Add group values only.*

Two methods of capturing coots were observed. In the most frequently used technique, an eagle flew low over the coots, flaring slightly, then lowering its talons to grasp a bird. This was accomplished in a relatively continuous, flowing motion where only the talons, if anything, hit the water. The other method involved an eagle circling or almost hovering over some coots and dropping onto them. This technique often resulted in a dunking for the eagle. With the probable exception of cottontails and jackrabbits, most mammalian prey was consumed as carrion. In a few areas, wintering eagles were apparently hunting lagamorphs quite consistently, as Edwards (1969) recorded in an essentially terrestrial winter population in the Great Basin of Utah.

Behavior

The bald eagles wintering in the Southwest in 1978 were both widely scattered and highly mobile. Some seasonal variations in numbers and distribution were due to transient eagles migrating to or from wintering areas. However, weather conditions, habitat suitability, and prey availability were the key factors in both migratory and local movements of wintering eagles within the region. Seasonal migration from the winter-

Figure 4.—A partially frozen lake in northern Arizona where wintering bald eagles frequently took advantage of the concentrated waterfowl.

ing grounds was associated with the warmer weather of early spring, while changes in temperature during the winter months affected diurnal activity. On extremely cold days, wintering eagles were relatively immobile, foraging very little, and remaining on perches or on the ice of a frozen lake through most of the day. On unusually warm days, general daytime activity increased, and the birds were frequently observed ranging away from the usual perching and foraging areas. In a few instances, heavy and prolonged snow seemed to cause movement away from lakes and rivers. A generalized diurnal activity pattern described primarily from observations in several areas of consistent concentrations is shown in table 6. Scattered individuals or small groups followed much the same pattern, but their distribution, small numbers, and apparent nomadic existence suggested opportunistic, noncommunal roosts.

Bald eagles wintering around lakes and reservoirs showed an habitual pattern of activity in contrast to a more mobile, opportunistic pattern of activity in eagles wintering along rivers. Eagles associated with standing bodies of water were more predictable, favoring specific perches, patterns of foraging, flight routes, etc. When disturbed, these eagles showed a tendency to return to their original location after the disturbance passed. Eagles wintering near rivers were apparently not so habituated to a specific set of habitat conditions. Individual birds were observed perching in a variety of locations with no noticeable preference for perviously used perches. On several occasions, eagles flushed by field personnel showed no inclination to remain in the area; instead these birds flew off along the river and did not return after the disturbance. Although on a regional scale it was not possible to quantify sightings into actual numbers of birds, there was a definite trend for immature eagles to occur in greater numbers around lakes and reservoirs than along river drainages.

Table 6.—Observed dirunal activity pattern of wintering bald eagles on southwestern National Forests in 1978

Time of day	Activity
Predawn	Leave roost for perching and/or foraging areas.
Sunrise	On loafing or hunting perches around foraging area or dispersing for foraging area.
Early-midmorning	Foraging.
Midmorning-midafternoon	Little activity, sunning, preening, occasional soaring.
Late afternoon	Increased activity, more foraging.
Sunset	Often begin movements toward roosting area.
Twilight into darkness	Usually on roost for night.

Discussion

Numbers and Distribution

The population estimates shown in table 2 are presented to document the findings of this pioneer effort in the Southwest and to provide a benchmark for comparison and refinement with future surveys. A comparison of the states' subtotals with the aerial survey results (80 in Arizona and 352 in New Mexico) suggest that in Arizona either the aerial results underestimated the population or the estimate derived from ground studies was exaggerated. Both explanations probably apply, but it does appear the majority of wintering bald eagles in Arizona are on National Forest lands. In New Mexico, the aerial surveys of 1978 and subsequent efforts (Hubbard 1979, Pramstaller et al. 1979) indicate a significant portion of the wintering eagle population is found off National Forest lands.

Regardless of actual numbers eventually documented, table 2, which is based on 1978 field data and supported by historical information, does provide a representative assessment of the relative importance of the various National Forests to wintering bald eagles. It should be noted, however, that specific field labor hour figures by themselves can be misleading because of several inherent biases: variation in observers and observation techniques, the inclusion of probable repeat sightings of the same eagles on different days, and the intentional concentration on areas known or expected to have wintering eagles. In addition, a small number of field labor hours can also exaggerate resulting indices when a few birds are seen (e.g., Prescott National Forest where the 2.00 FPH/sighting indicates a greater fequency of eagle encounters than actually occurs across the entire Forest). In contrast, numbers may be conservative for some National Forests. For example, many high country lakes were frozen and snow covered by the onset of this study on the Apache-Sitgreaves National Forest; and many other, normally used lakes were very low or dry from summer drought conditions on the Kaibab. This may have caused eagles which normally winter on this Forest to move elsewhere.

General Habitat

Few eagles appear to winter at lower elevations within the two states, despite the rather unique dichotomy of wintering habitats available. One might expect bald eagles migrating to Arizona for the winter to frequent the warm, dry, central desert lakes, rivers, and riparian areas; but the vast majority of wintering eagles remain in the ponderosa pine forests where they must endure snow and cold temperatures. The key to this behavior apparently lies in the prey base, which both fluctuates with (see Food Habits discussion), and is concentrated by normal winter conditions. Locally, the severity of winter conditions is directly related to elevation; whereas, regionally or geographically, latitude is the independent variable. The winter concen-

tration of many wildlife species, particularly waterfowl and big game, is well established (Leopold 1933, Linduske 1964, Moen 1973, and Taylor 1965). Thus, potential avian and mammalian prey species are most abundant and available within a range of winter conditions from those insufficient to cause concentration to those causing emigration or death. Figure 5 illustrates this relationship. Eagle numbers and concentrations in the Southwest appear to increase slowly to a peak prior to the time at which winter conditions cause prey emigration. This conceptual relationship presumes existence of sufficient water resources, roost sites, perches, freedom from disturbance, etc., and does not include a consideration of natural fish resources, which are much less affected by winter conditions than are avian or mammalian prey. Nevertheless, this hypothesis derived from field observations explains the distribution of wintering bald eagles in the Southwest.

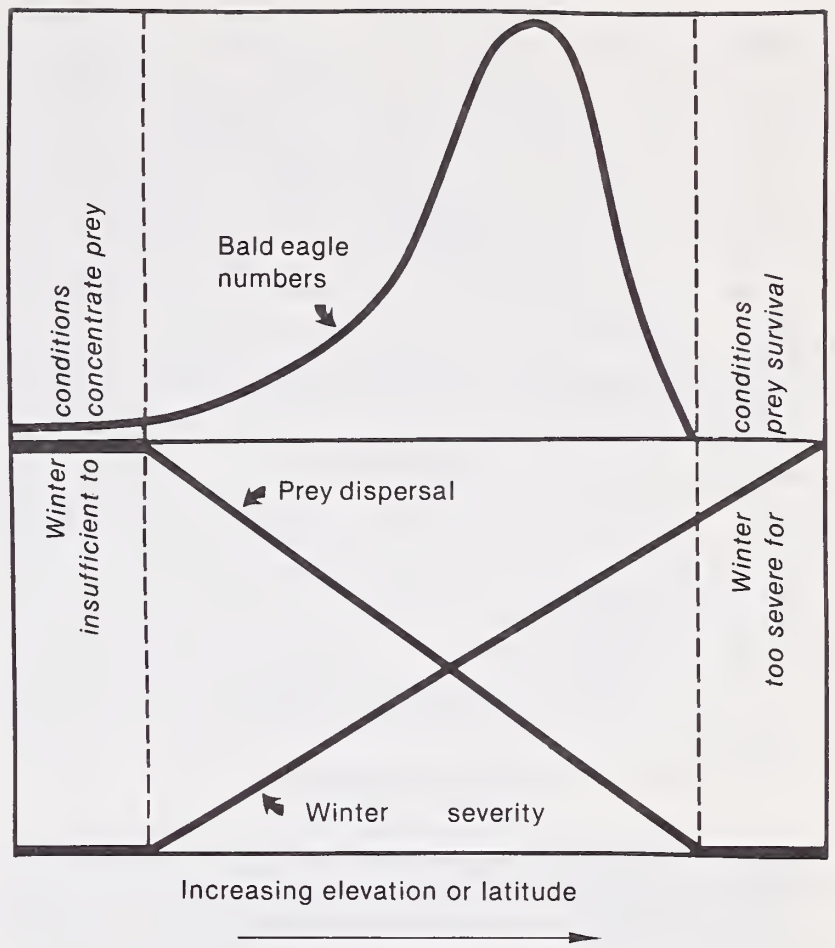

Figure 5.—A postulated relationship between elevation (local) or latitude (regional), prey dispersal (waterfowl and big game), and winter bald eagle distribution in the Southwest.

Perches

Perches are probably the least critical component of bald eagle winter habitat; and, although perching is the most typically observed activity, lack of perch sites rarely limits eagle populations. In a nesting situation, eagles appear to select trees on the basis of general characteristics such as relative height, stout branching, proximity to water, and stand heterogenity (Grubb 1980); there is no species preference per se. Similarly, winter perches which are used for a variety of loafing and foraging activities are chosen on the basis of availability, with visibility appearing to be the common denominator of several observed trends in perch characteristics. Normally, bald eagles perch in large trees and apparently prefer snags or dormant, deciduous species. However, they also frequently perch on a variety of other substrates such as lake ice, ridge top boulders, open-range junipers (fig. 6), etc.

Certainly water resources, proximity of foraging and roosting areas, weather conditions, and human activity have contributory effects on the selection of winter perches (Servheen 1975, Stalmaster and Newman 1979), but a pattern emerges from the observed range of perches which suggests the height of the perch is inversely proportional to the visibility from it (fig. 7). This is not to deny that visibility increases with height; however, over a range of environmental situations, minimum or obligate perch height does show a reciprocal relationship with visibility from the perch. This visibility is influenced by at least three interrelated habitat characteristics: openness, height of substrate, and height of surrounding vegetation. As the first two increase, the need for tall perches is reduced because visibility is maintained by the openness of the habitat or the height of the hill (e.g., perching on lake ice or on the rock of a high outcrop). However, an increase in the height of surrounding vegetation requires higher perches to sustain a view beyond the adjacent foliage. Recognition of these perching characteristics should facilitate an assessment of potential habitat and may provide a management tool for improving perch sites in marginal areas.

Figure 6.—Adult bald eagle on a typical low juniper perch in open range land in northern New Mexico.

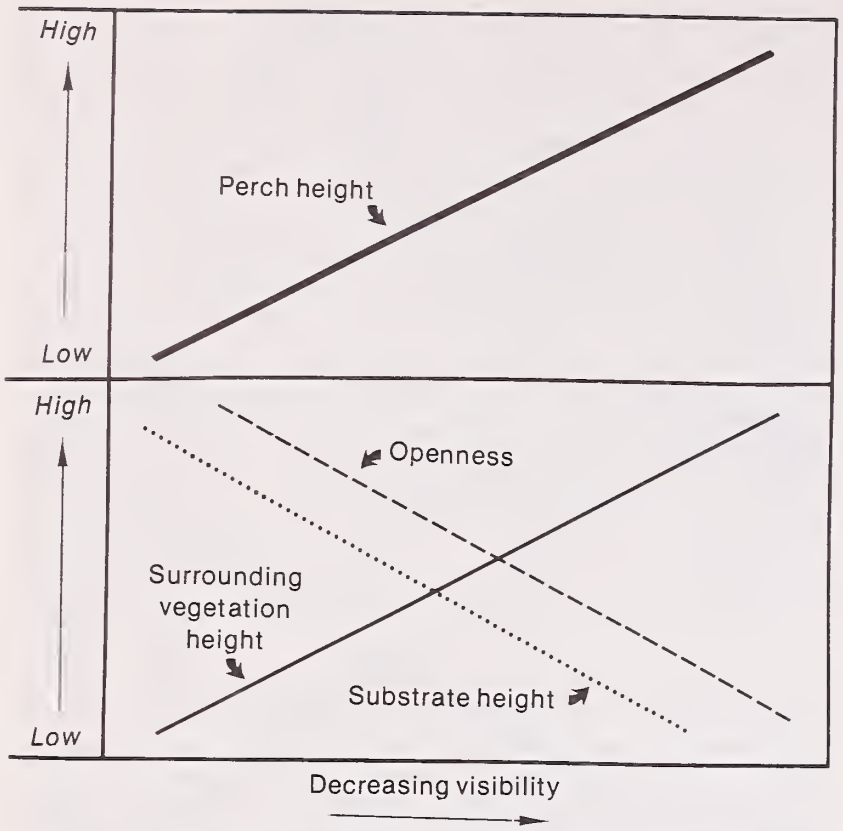

Figure 7.—The apparent relationship when perch height is considered dependent on visibility, which is influenced by openess, substrate height, and surrounding vegetation height.

Roosts

In contrast to perches, roosts are usually in live trees, in relatively dense stands, in protected situations such as draws or small drainages, often several miles from the daytime loafing and foraging areas. Communal roosts often represent consistent, high-density use by eagles and are one of the most important attributes of winter eagle ecology for management and/or protection (Steenhof 1978). Foraging and perching habits within an area may vary significantly through the winter, but those eagles involved may continue to use the same communal roost throughout the season (Edwards 1969). Unfortunately in the small, scattered population situation of the Southwest, roosts are very difficult to locate. A significant investment of time is required to find the eagles and become familiar enough with their diurnal pattern of activity to eventually follow them to roost. The difficulties are compounded by roosting flights' often being after dark or before dawn. Thus remains the irony that the most stable and perhaps the most critical component of eagle winter habitat is the least known in the Southwest. Roosts located distant from areas of observed concentrations may be subject to incompatible land practices because eagles are not obviously associated with the area. Roosts may also be the key to documenting the widely dispersed individuals and small groups ranging over terrestrial or upland habitat. Whether these birds come together in communal roosts is as yet unknown; but if they do, such roosts could be critical to the physical and behavioral maintenance of that population.

Food Habits

As mentioned in the discussion of prey dispersal and winter severity, the bald eagle's avian and mammalian prey base also fluctuates with winter weather conditions, and in so doing, provides additional advantage to the eagles wintering in the harsher climates of the Southwest. In mild to normal winters or early in the season, many lakes and rivers support large populations of waterfowl which are a major source of prey for bald eagles. As the severity of winter increases, the waterfowl become more vulnerable in concentrations on the small areas of remaining open water. If as the season progresses, or during a severe winter, most bodies of water are frozen over, the waterfowl emigrate, leaving the eagles with a reduced avian prey source. However, such conditions usually lead to an increase in both the winter kill of big game and the vulnerability of small mammals such as cottontails and jackrabbits. Thus, prey populations fluctuate as winter conditions dictate, but the opportunistic eagle has a consistent, although variable, prey base (fig. 8).

The extent to which mammalian prey or carrion was utilized during this study was difficult to ascertain because the nature of this food source leads to widely dispersed foraging activity. There may be a sizeable population of wintering eagles wandering throughout the rangelands of Arizona and New Mexico and feeding on large ungulate and livestock carcasses or taking small mammals. Associated with this variation in prey resources is a variation in mobility. Eagles which feed on waterfowl or fish tend to congregate and remain around specific water resources, whereas those utilizing mammalian prey appear to be widely ranging. The

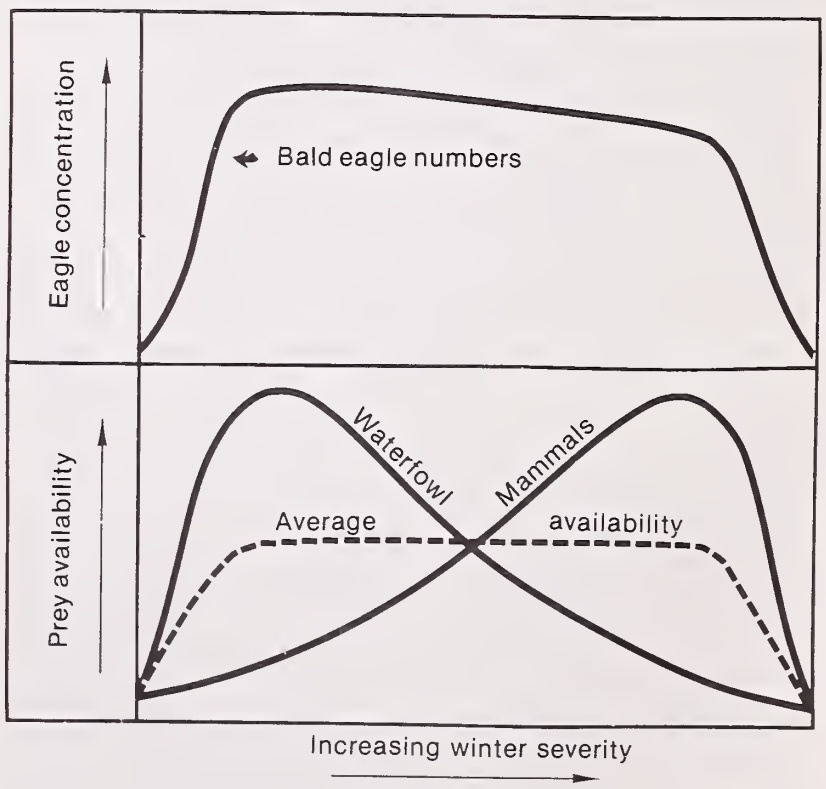

Figure 8.—The apparent fluctuation of avian and mammalian prey leading to a relatively stable, average prey base as winter severity varies and the resultant, postulated change in bald eagle concentration (or dispersal).

latter necessarily must be more opportunistic in the role of scavengers, yet communal roosting in this situation may also function as a means of exchanging information on the whereabouts of food resources (Ward and Zahavi 1973). It is also possible that eagles in the more traditional wintering areas are utilizing habitat away from water during periods of the winter season. The variety in diet and the eagle's opportunistic nature evidence evolution away from a strictly "sea eagle" bond to water (or the reverse, i.e., incomplete evolution toward fish-eating from a generalist's role[7]). Fish appear to be utilized by bald eagles wintering in the Southwest, but initial data indicate avian and mammalian prey to be more important. Unfortunately, fish provide little roughage and, therefore, are rarely evident in castings (table 5) (Lish 1975, Steenhof 1976).

Behavior

Behavior patterns observed during this study are similar to those throughout the bald eagle's wintering range (Spencer 1976); however, the lack of large concentrations and the extent of widely scattered individuals and small groups are relatively unusual. Both factors compound the difficulty of quantifying habitat needs and behavioral characteristics. The tendency of river dwelling eagles to flush and not return for at least an appreciable time probably reflects the more variable habitat and prey conditions found along river situations during winter months. In contrast, lakes and reservoirs provide more stable conditions, permitting increased habituation to the local environment and subsequent development of identifiable behavioral patterns. The higher proportion of immature eagles in these situations may be associated with the greater concentrations of both eagles and prey, and the more consistent activity patterns. The less experienced immature eagles would seem to have a better chance of finding food and roosting or perching safely. The theoretical advantage of group roosting and foraging for transmittal of prey locations (Ward and Zahavi 1973) has been supported by studies of wintering eagles in western Washington (Hansen et al. 1981, Servheen 1975). The harsher wintering conditions and the lack of social interaction along river habitats may well select against all but the more experienced adults and the most competitive immature bald eagles.

Recommendations

This study, although extensive, was limited to one field season; therefore, much of the information presented has necessarily been qualitative instead of quantitative. Only subsequent years of data can establish norms and trends in habitat utilization, population numbers and distribution. To facilitate future interpretations, more research is needed on numbers, distribution, season/diurnal movements, perching, roosting, and foraging habits. From a management standpoint, location of roosts is a high priority, followed by locating foraging areas and then perching/loafing sites. Specific habitat and population characteristics must eventually be determined for those scattered eagles consistently utilizing upland or terrestrial habitat. Both aerial and ground techniques should be employed on any future habitat studies. Aerial surveys can document the numbers, distribution, and seasonal fluctuations; whereas, ground observation is necessary to describe food habits, behavior, and specific use areas. Aerial surveys should be flown in late fall (October-November), midwinter (January-February), and early spring (March-April). Actual timing of these flights should be based on the severity of the winter and local habitat conditions, but field personnel conducting ground surveys and habitat analyses should be deployed by November 1. The aerial surveys can determine the best areas for ground observation throughout the winter season.

[7]*Sergey Postupalsky, Wildlife Ecologist, University of Wisconsin, February 21, 1981, personal communication.*

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Appendix

Fauna List[1]

Bald eagle	*Haliaeetus leucocephalus*
American coot	*Fulica americana*
Mallard	*Anas platyrhynchos*
Pintail	*Anas acuta*
Carp	*Cyprinus carpio*
Bluegill	*Lepomis macrochirus*
Pumpkinseed	*Lepomis gibbosus*
Brown bullhead	*Ictalurus nebulosus*
Northern pike	*Esox lucius*
Rainbow trout	*Salmo gairdneri*
Golden shiner	*Notemigonus crysoleucas*
Elk	*Cervis canadensis*
Deer	*Odocoileus* spp.
Pronghorn (Antelope)	*Antilocarpa americana*
Cottontail	*Sylvilagus* spp.
Black-tailed jackrabbit	*Lepus californicus*
Woodrat	*Neotoma* spp.
Freshwater mussel	*Anodontia corpulenta*
Scarab beetle	Family Scarabaeidae
Jerusalem cricket	Family Gryllacrididae

Flora List[2]

Ponderosa pine	*Pinus ponderosa*
Pinyon pine	*Pinus edulis*
Juniper	*Juniperus* spp., *J. utahensis*
Douglas-fir	*Pseudotsuga menziesii*
Cottonwood	*Populus* spp.
Scrub oak	*Quercus* spp.

[1]*A.O.U. (1957), Burt and Grossenheider (1964), Lee et al. (1980), and Pennak (1953).*
[2]*Preston (1965).*

Agriculture—CSU, Fort Collins

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An extensive, winter survey and habitat study in 1978 located about 100 bald eagles in Arizona and 350 in New Mexico. Perching habits varied greatly but predictably. Limited in number and consistently used, roosts appear to be the most critical for management. Fluctuations in prey populations provided the opportunistic eagle with a food base changing in composition but consistent in overall availability. Study results offer some qualitative insights for habitat managers.

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Rocky
Mountains

Southwest

Great
Plains

U.S. Department of Agriculture
Forest Service

Rocky Mountain Forest and Range Experiment Station

The Rocky Mountain Station is one of eight regional experiment stations, plus the Forest Products Laboratory and the Washington Office Staff, that make up the Forest Service research organization.

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